

Interpersonal violence and overweight in adolescents:

The HUNT Study

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ABSTRACT

Aims

Overweight and obesity in children and adolescents are major public health challenges associated with psychosocial adversity and unfavorable lifestyle. Exposure to interpersonal violence, such as sexual abuse, violence and bullying, could represent precursors, accelerating or sustaining factors.

Methods

The Young-HUNT 3 study, 2006-2008, is a population-based, cross-sectional, cohort study of Norwegian youth that includes self-report data on exposure to interpersonal violence; pubertal status and timing; socioeconomic, psychosocial, and lifestyle factors; and clinical anthropometric measures. A cohort of 10464 adolescents aged 12–20 years from Nord-Trøndelag County were invited to participate. Body mass index served as the outcome in the simple and multiple linear regression analyses.

Results

The response rate was 72.3% (7564), and 49.9% (3777) of the respondents were girls. A robust and significant relationship between interpersonal violence and increased BMI for both genders was found. Importantly, interpersonal violence remained significantly correlated with higher BMI following adjustment for pubertal development, socioeconomic and psychosocial adversity and unfavorable lifestyle factors in both genders, although most evident in girls. Adjusted regression coefficients (95% confidence intervals) for the relationship between interpersonal violence and BMI were 0.33 (0.01, 0.65) for 1 type and 0.89 (0.37, 1.41) for 2 types, compared to no exposure in girls, and 0.40 (0.09, 0.71) for 1 type and 0.35 (-0.09, 0.79) for 2 types of interpersonal violence in boys.

Conclusions

The empirical evidence of consistent associations between interpersonal violence, related psychosocial and lifestyle factors, and body fatness, indicates that these features play important roles for adolescents struggling with overweight.

Keywords: adolescence, overweight, obesity, bullying, interpersonal violence, sexual abuse, psychological distress, loneliness, family, lifestyle

Introduction

Overweight and obesity in children and adolescents are major public health challenges that are currently disproportionately affecting socioeconomically disadvantaged families in high-income countries.¹ The prevalence rates are comparable between genders, although etiological factors may vary, especially after transition to puberty.^{2, 3} Adolescence, due to its physical, psychological, and social challenges, may represent a vulnerable developmental phase with regard to excess weight gain. Cardiovascular and metabolic disease risk increases exponentially with higher body mass index (BMI) in overweight and obese children and adolescents.⁴ Pathological body fatness is additionally associated with somatic and psychological disorders and social and learning problems.² Adverse health outcomes commonly persist and are exacerbated in adulthood, as overweight and obese children often become obese adults.⁵ Nevertheless, if overweight or obese children or adolescents are able to normalize their weight, the adult risk is neutralized.⁵ Such normalization of weight most commonly occurs during early adolescence,⁵ in individuals who thrive and perform well academically,⁶ and is most likely facilitated by the pubertal growth spurt. In contrast, children and adolescents struggling with low self-esteem, loneliness, eating problems, or mental or behavioral disorders seem to be at increased risk of maintaining or developing obesity during the transition from adolescence to young adulthood.^{2, 6} Therapy resistance in this group of adolescents is high, particularly if parents are unsupportive or disengaged.⁷

Exposure to violence, sexual abuse and bullying is common in childhood and adolescence, and many are subjected to multiple types of interpersonal violence and other childhood adversity in and over time.⁸ Childhood exposure has consistently been linked to an increased risk of adult obesity, but documentation of the associations in childhood and adolescence is sparse.⁹ To our knowledge, the relationship between interpersonal violence, body fatness, and the multiple related etiological factors such as pubertal development, socioeconomic,

psychosocial and lifestyle features, has not yet been explored in a general population of adolescents. Increased knowledge of these relationships may be helpful in targeting prevention and tailoring weight management in the developmental phase of adolescence, when intervention may still be effective and welcome.

We hypothesized that exposure to violence, sexual abuse and bullying was associated with higher BMI in a representative, population-based cohort of adolescents. Psychosocial and lifestyle factors were expected to partially account for this association. Socioeconomic status, age, pubertal status, and timing were hypothesized to be confounders, whereas gender was hypothesized to differentially affect the strength of relationships.

Methods

The Young-HUNT 3 (<http://www.ntnu.edu/hunt/inenglish>) population-based cohort of Norwegian youth from Nord-Trøndelag County used in this cross-sectional study has been described in previous publications.¹⁰ Briefly, data were collected from 2006 to 2008. The study is comprised of a school-based, self-report, general health questionnaire that includes items on exposure to potentially traumatic events, pubertal development, and socioeconomic, psychosocial, and lifestyle factors (<http://www.ntnu.edu/hunt/data/que>), as well as a clinical assessment by trained staff within a month of completion of the questionnaire. The Norwegian Regional Committee for Medical and Health Research Ethics approved the study. Inclusion was based on informed written consent from participants aged 16 years and older and from the parents of individuals less than 16 years of age, in accordance with Norwegian law.

Participants

In 2006, the population in Nord-Trøndelag was primarily ethnic Norwegian; the adult population was well educated, on average; the employment rate was high; and society was characterized by socioeconomic equality. All 10464 adolescents who inhabited Nord-Trøndelag County in 2006 were invited to participate in this school-based study. Non-participation was mainly due to lack of enrollment, absenteeism, or participation in class activities outside of school. The overall response rate was 78.4% to the questionnaire, whilst 73.7% of the total of adolescents responded to the questionnaire and underwent a subsequent clinical examination. Response-rates were highest among junior high school students, and lowest among adolescents not in school.¹⁰ Most of the adolescents were between 13 and 18 years old, although the ages ranged from 12-20 years. The 33 adolescents who were 20 years of age or more were excluded, in compliance with the World Health Organization (WHO)

definition of adolescence. In total 7564 (72.3%) adolescents under 20 years of age had completed the questionnaire and the clinical assessment, 3777 (49.9%) of whom were girls.

Anthropometrics

BMI is currently the recommended measure of relative body fatness in epidemiological studies of children and adolescents. Adjustment for pubertal status has been debated but remains to be implemented, mainly due to practicalities.² In this study, BMI (weight in kilograms/ (height in meters)²) was calculated from height and weight as measured by trained staff. To enable the comparison of prevalence rates with other populations and to enhance clinical applicability, BMI-derived categorization of obesity, overweight, and underweight were defined following the International Obesity Task Force (IOTF) criteria for adolescents.¹¹

Age, Gender, and Pubertal Development

Information on gender and age was obtained from the Norwegian National Population Registry. Pubertal status was assessed using the validated self-report Pubertal Developmental Scale (PDS)¹² and associated with the development of secondary sex characteristics. The scale range of 1-4 corresponds to the Sexual Maturity Rating (SMR) of I-V, where SMR I represents preadolescence and SMR V represents physical maturity. Cronbach's alphas were 0.79 (boys) and 0.67 (girls). Early pubertal timing was defined as self-reported menarche before the age of 12 in girls and self-rated pubertal maturation somewhat earlier or much earlier than that in peers in boys.¹³

Sociodemographics

The sociodemographic variable 'family structure' differentiated between 'living with both parents' versus 'living without both parents'. Socioeconomic status labeled 'family economy',

was measured as the self-reported estimation of family affordance compared with that of most other families, and was categorized as ‘above average’, ‘average’, or ‘below average’.

Interpersonal violence

Lifetime exposure to violence, sexual abuse and bullying was measured by the following items: i) observed others being subjected to violence, ii) was subjected to violence (beaten or injured), iii) was subjected to unpleasant/disagreeable sexual acts by someone of approximately the same age, iv) was subjected to unpleasant/disagreeable sexual acts by an adult, and v) was threatened or physically harassed by fellow students at school over a period of time. The dichotomous items were labeled as exposure to ‘witnessing violence’, ‘violence’, ‘bullying’, ‘sexual abuse by peer’, and ‘sexual abuse by adult’. These types of exposure were collectively labelled ‘interpersonal violence’. The numbers of types of exposure were added in individual sum-scores (range 0-5). Scores of 3 or above were combined due to the low incidence of such scores.⁸

Psychosocial Factors

Loneliness was measured on a five-point Likert scale using a one-item variable termed ‘Does it happen that you feel lonely?’, ranging from 1=‘*never or very rarely*’ to 5=‘*very often*’. In line with current recommendations,¹⁴ this measure focused solely on the experience of loneliness, without assessment of hypothesised causes. *Self Esteem* was measured using a short version¹⁵ of the Rosenberg Self-Esteem Scale, where adolescents rated 4 statements on self-perceptions related to attitude toward oneself, feeling of uselessness, having something to be proud of, and self-worth. A higher score, in the range of 1-4, represented higher self-esteem. Cronbach’s alphas were 0.78 (girls) and 0.71 (boys). *Psychological Distress* was measured using a validated, 5-item, short version¹⁶ of the 25-item Hopkins’s Symptom Checklist (HSCL) subscale on anxiety and depression, assessing nuisance related to fear or

anxiety, tension/distress or restlessness, hopelessness, dejection or sadness, and excessive worry over the previous 14 days. Cronbach's alphas were 0.83 (girls) and 0.80 (boys). *Family Cohesion* was measured using a short form of the family cohesion subscale of the Resilience Scale for Adolescents (READ).¹⁷ Adolescents rated their well-being within their families, degree to which their families shared values, positive expectations and hope despite adversity, and support of each other over the previous month. The mean score ranged from 1-5, where the highest measurable level of family cohesion was scored as 5. Cronbach's alphas were 0.87 (girls) and 0.85 (boys).

Lifestyle

Eating more frequent meals has been associated with a lower prevalence of overweight and obesity in children and adolescents.¹⁸ *Eating Frequency* was the estimated mean of adolescents' reports of how frequently they ate breakfast, lunch, a warm dinner, and supper, ranging from 1='seldom or never' to 4='every day'. A three-item subscale,¹⁹ derived from the Eating Attitudes Test (EAT), was used to assess eating problems. The three items on food preoccupation, lack of control, and binge eating were rated from 1-4, where 1=never and 4=always. Cronbach's alphas were 0.75 (girls) and 0.67 (boys). *Physical Activity* was measured using a validated question on frequency of vigorous physical activity from the WHO Health Behavior in School Children (HBSC) questionnaire.²⁰

Statistics

Overweight generally affect both boys and girls.¹ However, gender-related discrepancies in psychosocial and lifestyle related risk factors are observed.³ Data were therefore presented stratified by gender based on this a priori reasoning. Descriptive sociodemographic data were primarily presented by the IOTF-defined categories of underweight, normal weight,

overweight, and obesity¹¹ (Table 1). Data were presented according to total exposure to interpersonal violence (Table 2).

The aim of regression analyses was to estimate the relationships of interpersonal violence exposure and related socioeconomic, psychosocial, and lifestyle factors with body fatness, adjusting for age and pubertal status. Continuous BMI served as the outcome measure in simple and multiple linear regression analyses (Table 3). In our sample, few adolescents were underweight (n=302) compared with overweight and obese (n=1842). We therefore focused on a high BMI as the primary weight problem in our sample. Underweight adolescents were excluded from these analyses to enhance the interpretation of the results, as we expected that the applied covariates could be associated with both higher and lower BMI.²¹

Heteroscedasticity, potentially reflecting a relationship between increased exposure to interpersonal violence and both extremes of the BMI continuum, was assessed by variance inflation factor (VIF). Multiple imputation methods, with 200 imputed datasets, were used to reduce selection bias. Complete case analyses were conducted for comparison.

Finally, we plotted height across age during adolescence by gender, as height increases may ‘buffer’ the effects of risk factors on body fatness (Figure 1).

Analyses were conducted using SPSS version 20 in combination with the R (The R Foundation for Statistical Computing, Vienna, Austria) package rms and Hmisc, which were used for multiple imputation.

Results

In the present study, approximately one in four adolescents was overweight (including obese) and 5% of girls and 6 % of boys were obese (Table 1). Overweight and obese boys and girls more often reported any and multiple exposures to interpersonal violence, compared with their normal- and under-weight peers. Socioeconomic adversity and early pubertal timing were related to a higher prevalence of overweight and obesity in both genders.

As the distributions of exposure to violence, sexual abuse and bullying and pathological body fatness in child and adolescent populations follow similar socioeconomic, psychosocial, and lifestyle patterns, these factors and adverse outcomes may be interrelated. Table 2 displays in more detail how levels of exposure to interpersonal violence and well-known risk and protective factors associated with adiposity in adolescence, are distributed. Exposure to interpersonal violence was reported by 25% of girls and 33% of boys, with 4% of both genders reporting exposure to three or more such events. Approximately two-thirds of the exposed adolescents had experienced one type of interpersonal violence, primarily witnessing violence. Adolescents exposed to violence, bullying, or sexual abuse commonly reported two or more events. We observed an apparent increase in socioeconomic and psychosocial adversity and unfavorable lifestyle across all levels of exposure to interpersonal violence.

The linear regression analyses revealed significant relationships between the sum of exposure to interpersonal violence and higher body mass index (BMI) in both genders (Table 3).

Importantly, these relationships remained significant in the multivariate analyses for both genders, although somewhat less evident in boys. Adverse socioeconomic, psychosocial and lifestyle factors were related to higher BMI in bivariate analyses. Low self-esteem, skipping meals and eating problems remained significantly correlated with higher BMI in the adjusted analysis for both genders. Additionally loneliness in girls and low physical activity in boys

remained significantly associated with higher BMI in the multivariate analyses. Contrary to expectations psychological distress was inversely related to higher BMI in multivariate analysis for both genders. As expected, higher age, advanced pubertal status, and early pubertal timing predicted higher BMI in both genders in the bivariate and multivariate analyses.

Pubertal maturation including height growth varies by sex throughout adolescence. Knowing that BMI heavily depend on height our results must be interpreted in light of population specific height measures. As expected, girls reached their peak height at approximately 15 years of age, while boys' height on average increased throughout adolescence, leveling out in late adolescence (Figure 1).

We found no indication of heteroscedasticity in the data or substantial deviations in results when comparing results from multiple imputation and complete case analyses.

Discussion

To our knowledge, this is the first population-based study to comprehensively assess the associations between exposure to violence, sexual abuse and bullying and body fatness in adolescence. The study documents a robust and significant relationship between exposure to interpersonal violence and increased BMI for both genders. Despite adjustment for a comprehensive range of known risk factors exposure to interpersonal violence remained significantly correlated with higher BMI in the full model. This finding indicates that such exposure may play an important role in relation to adiposity in adolescence.

The major strengths of this study were the large sample size, the overall high participation rate, the use of physiologically and clinically relevant measures of relative body fatness, and the opportunity to assess the impact of several types of interpersonal violence- and adiposity-related risk and protective factors within a population-based cohort of adolescents.

Importantly, the retrospective, cross-sectional study design did not allow for causal inference or differentiation between confounding and mediational effects. The lower response rate among adolescents in senior high and adolescents not enrolled in school may have led to an underestimation of associations.¹⁰ The one-item measure of loneliness is a limitation. Our measures of violence, sexual abuse and bullying exposure lack event-specific information on severity. Further we lacked information on genetic plasticity, parental factors, such as parental obesity, eating disorders, mental health, care and rejection and community adversity.^{2, 22} Despite these potential selection biases and measurement limitations, it is likely that the main findings can be generalized to other adolescent populations.

In our sample, the combined prevalence of overweight and obesity of 25% (5% obesity) agreed with reported European rates during the same time period,¹ but exceeded corresponding national prevalence rates.²³ Over one decade, we observed a near doubling of the obesity prevalence in adolescents within the same geographical area,²⁴ consistent with the

secular global obesity trend.¹ Furthermore, the observed comparable rates of obesity and overweight between the genders, despite differences in related psychosocial and lifestyle factors, were consistent with the rates found in previous studies.¹

Our main findings substantiate recent but scarce evidence of a significant association between exposure to interpersonal violence and higher or more rapidly increasing BMI starting in adolescence.^{21, 25, 26} In two of these previous studies only one type of interpersonal violence was assessed, and the sample sizes were smaller than that in the present study. The third study used self-report weight and height.²¹ None adjusted for pubertal status as an important confounding factor.

However, childhood adversity, including exposure to interpersonal violence, has previously consistently been linked to adult obesity.⁹ With regard to the temporality of events, prospective studies indicate that early exposure to maltreatment may be causally related to adult overweight and obesity.^{26, 27} In adolescents, bullying has been linked to the onset²⁵ and exacerbation of pathological weight gain, possibly particularly in girls.²⁸ In some children and adolescents their overweight or obesity may put them at direct increased risk of bullying victimization.²⁵ However, children and adolescent previously exposed to maltreatment are more likely to experience other interpersonal violence, including bullying, compared to their non-exposed peers.^{8, 29} Thus, exposure to interpersonal violence may play a key role in fuelling the onset and persistence of pathological weight gain in susceptible adolescents.

Multiple factors may mediate this relationship as early exposure to violence, sexual abuse, or bullying in interplay with individual and coinciding environmental risk and protective factors may modify physiological, psychological, and behavioral processes, affecting metabolism, energy intake and expenditure which further increase susceptibility to excess weight gain.^{9, 22,}

In particular exposure to violence may induce posttraumatic stress reactions clustering as re-experience, avoidance, negative alterations in cognition and mood, physiological hyper-activation, and somatic complaints such as pain. These cognitive, emotional, somatic and physiological responses may disturb behavior and thereby social relations, lifestyle and function. Over time physiological hyper-activation or dysregulation, disturbing metabolism, hunger and cravings, lack of agency and motivation, and alterations in behavior such as social withdrawal, difficulties in structuring everyday activities such as sleep, meals and physical activity, or disturbed eating patterns may facilitate a positive energy balance, leading to gradual weight-gain.^{9, 30} Taken together, exposure to violence may induce multiple interacting physiological, psychosocial and behavioral reactions increasing risk of overweight and other adverse health outcomes.

The main results of the present study were similar across gender, although most evident for girls. The discrepancies in findings may be related to gender-biased differences in pubertal maturation and physiology,² social role expectations and limitations,³ or sex differences in the panorama interpersonal violence, such as girls being at greater risk of sexual abuse.²⁶ Particularly notable is the possibility that the anabolic male hormone profile and prolonged height growth in boys may buffer the effect of risk factors, such as exposure to interpersonal violence, on psychological health³⁰ and pathological weight gain.

Public Health and Clinical Implications

Our study indicates that multiple adverse psychosocial and lifestyle factors may increase risk of excess weight gain in adolescents, in line with current knowledge of the multi-factorial etiology of overweight. Moreover, our findings suggest that exposure to interpersonal violence may pose a crucial risk factor for overweight, comparable to the risk of well-

established unfavorable lifestyle factors, such as inactivity. A biopsychosocial approach is therefore warranted to accommodate adolescents' somatic, psychosocial, and lifestyle challenges and needs in preventive public health efforts targeting adolescent overweight and obesity. In order to tailor interventions and facilitate coping in adolescents struggling with overweight it may be helpful to screen for exposure to violence, sexual abuse, bullying, and psychosocial adversity, alongside habits of eating and exercise. Trauma-informed, social relationship-based interventions may represent a major opportunity to alter the high-risk trajectories of obesity.

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Declaration of Conflicting Interests

Synne Øien Stensland, Siri Thoresen, Tore Wentzel-Larsen and Grete Dyb declare no potential conflict of interest, real or perceived. The authors have no financial relationships relevant to this article to disclose.

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Figures and Tables

Figure 1. Figure intended for color reproduction

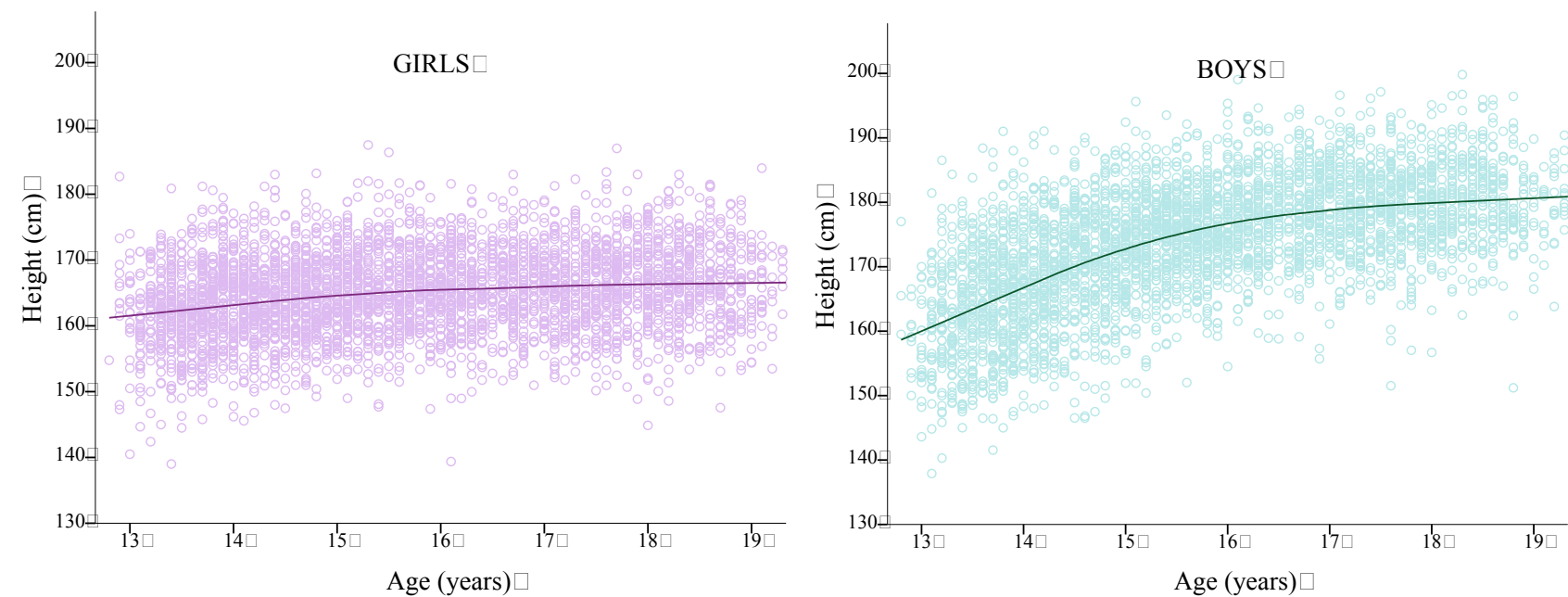


Figure A1. Height in 3777 girls and 3787 boys according to age across adolescence.

Table 1

TABLE 1 Age and Development, Socioeconomics, and Exposure to Interpersonal Violence According to the BMI-Defined Underweight, Normal-weight, Overweight, and Obesity Classifications of 7564 Adolescents. ^{ab}							
	N	BMI					p
		All	Under-weight	Normal-weight	Over-weight	Obese	
		n (%), mean (SD)	n (%), mean (SD)	n (%), mean (SD)	n (%), mean (SD)	n (%), mean (SD)	
Girls	3777		178 (5)	2747 (73)	670 (18)	182 (5)	
<i>Age and Development</i>							
Age	3777	15.8 (1.7)	15.5 (1.7)	15.8 (1.7)	16.0 (1.7)	16.1(1.7)	0.001 ^c
Pubertal status	3279	3.3 (0.6)	2.9 (0.7)	3.3 (0.6)	3.4 (0.5)	3.4 (0.6)	<0.001 ^c
Early pubertal timing	3287	521 (16)	7 (5)	344 (14)	133 (23)	37 (25)	<0.001 ^d
<i>Socioeconomy</i>							
Living without both parents	3741	1299 (35)	52 (29)	919 (34)	257 (39)	71 (39)	0.025 ^d
Family economy below average	3576	348 (10)	10 (6)	235 (9)	76 (12)	27 (16)	0.007 ^d
<i>Exposure to Interpersonal violence</i>	3609						<0.001 ^d
No		2693 (75)	142 (83)	2004 (76)	445 (70)	102 (60)	
1 type		582 (16)	16 (9)	420 (16)	104 (16)	42 (25)	
2 types		196 (5)	7 (4)	121 (5)	53 (8)	15 (9)	

≥3 types		138 (4)	7 (4)	83 (3)	36 (6)	12 (7)	
Boys	3787		124 (3)	2673 (71)	749 (20)	241 (6)	
<i>Age and Development</i>							
Age	3787	15.8 (1.7)	15.7 (1.6)	15.7 (1.7)	15.8 (1.7)	15.9(1.7)	0.347 ^c
Pubertal status	3232	2.9 (0.7)	2.5 (0.8)	2.9 (0.7)	3.0 (0.7)	3.0 (0.6)	<0.001 ^c
Early pubertal timing	3282	670 (20)	12 (11)	427 (18)	183 (28)	48 (23)	<0.001 ^d
<i>Socioeconomy</i>							
Living without both parents	3747	1167 (31)	33 (27)	780 (29)	258 (35)	96 (40)	<0.001 ^d
Family economy below average	3463	275 (8)	11 (10)	174 (7)	62 (9)	28 (13)	0.061 ^d
<i>Exposure to Interpersonal violence</i>	3526						0.004 ^d
No		2345 (67)	81 (71)	1705 (68)	423 (61)	136 (62)	
1 type		727 (21)	25 (22)	480 (19)	171 (25)	51 (23)	
2 types		321 (9)	8 (7)	214 (9)	72 (10)	27 (12)	
≥3 types		133 (4)	-	100 (4)	26 (4)	7 (3)	

BMI, Body Mass Index; N, Number; SD, Standard Deviation.

^aCorresponding BMI (kg/m²) at ≥18 years; Underweight, BMI <18.5 kg/m²; Normal-weight, BMI ≥18.5 and <25 kg/m²; Overweight, BMI ≥25 and <30 kg/m²; Obese, BMI ≥30 kg/m².

^bBecause of rounding, percentages may not total 100%.

^cANOVA, analysis of variance

^dPearson χ^2 test

Table 2

TABLE 2 Type of Exposure to Interpersonal Violence, Socioeconomics, Psychosocial Factors, and Lifestyle According to the Sum of Victimizations in 7135 Adolescents. ^a						
	N	Exposure to Interpersonal Violence				p
		No	1 type	2 types	≥3types	
		n (%), mean (SD)	n (%), mean (SD)	n (%), mean (SD)	n (%), mean (SD)	
Girls	3609	2693 (75)	582 (16)	196 (5)	138 (4)	
<i>Interpersonal violence</i>						
Witness to violence		-	345 (59)	156 (80)	118 (86)	
Violence		-	42 (7)	94 (48)	113 (82)	
Bullying		-	103 (18)	62 (32)	94 (68)	
Sexual abuse, peer		-	62 (11)	52 (27)	86 (62)	
Sexual abuse, adult		-	29 (5)	28 (14)	68 (49)	
<i>Socioeconomy</i>						
Living without both parents	3582	799 (30)	249 (43)	94 (48)	92 (67)	<0.001 ^c
Family economy below average	3502	194 (7)	73 (13)	32 (17)	41 (31)	<0.001 ^c
<i>Psychosocial Factors</i>						
Feeling lonely	3519					<0.001 ^c
Never		777 (30)	91 (16)	24 (13)	17 (13)	
Seldom		986 (38)	171 (30)	49 (26)	15 (12)	

Sometimes		639 (24)	217 (38)	72 (38)	48 (37)	
Often		136 (5)	65 (11)	20 (10)	20 (15)	
Very often		89 (3)	27 (5)	26 (14)	30 (23)	
Self-esteem, (1-4)	3609	3.0 (0.6)	2.8 (0.6)	2.7 (0.7)	2.5 (0.7)	<0.001 ^b
Psychological distress, (1-4)	3564	1.5 (0.5)	1.8 (0.6)	2.0 (0.7)	2.4 (0.8)	<0.001 ^b
Family cohesion, (1-5)	3492	4.3 (0.8)	3.9 (1.0)	3.8 (1.0)	3.4 (1.2)	<0.001 ^b
<i>Lifestyle Factors</i>						
Meal frequency, (1-4)	3557	3.5 (0.6)	3.2 (0.7)	3.1 (0.7)	3.0 (0.8)	<0.001 ^b
Eating problems, (1-4)	3559	1.4 (0.5)	1.6 (0.6)	1.7 (0.6)	1.7 (0.7)	<0.001 ^b
Physical activity, (1-7)	3570	5.1 (1.2)	4.9 (1.3)	4.6 (1.4)	4.4 (1.6)	<0.001 ^b
<hr/>						
Boys	3526	2345 (67)	727 (21)	321 (9)	133 (4)	
<i>Interpersonal violence</i>						
Witness to violence			559 (77)	289 (90)	126 (95)	
Violence			61 (8)	257 (80)	119 (89)	
Bullying			98 (13)	74 (23)	120 (90)	
Sexual abuse, peer			6 (1)	18 (6)	54 (41)	
Sexual abuse, adult			3 (-)	4 (1)	48 (36)	
<i>Socioeconomy</i>						
Living without both parents	3503	652 (28)	245 (34)	132 (41)	45 (34)	<0.001 ^c
Family economy below average	3382	143 (6)	64 (9)	39 (13)	21 (17)	<0.001 ^c

Psychosocial Factors

Feeling lonely	3377					<0.001 ^c
Never		1038 (46)	246 (35)	95 (31)	25 (20)	
Seldom		751 (33)	249 (36)	93 (30)	29 (23)	
Sometimes		363 (16)	152 (22)	83 (27)	33 (27)	
Often		58 (3)	32 (5)	21 (7)	18 (15)	
Very often		38 (2)	18 (3)	16 (5)	19 (15)	
Self-esteem, (1-4)	3400	3.3 (0.5)	3.2 (0.6)	3.1 (0.6)	2.9 (0.6)	<0.001 ^b
Psychological distress, (1-4)	3452	1.3 (0.4)	1.4 (0.5)	1.6 (0.5)	1.8 (0.7)	<0.001 ^b
Family cohesion, (1-5)	3395	4.4 (0.7)	4.2 (0.8)	4.0 (0.9)	4.0 (1.0)	<0.001 ^b

Lifestyle Factors

Meal frequency, (1-4)	3473	3.6 (0.5)	3.5 (0.5)	3.4 (0.6)	3.4 (0.6)	<0.001 ^b
Eating problems, (1-4)	3491	1.2 (0.4)	1.4 (0.5)	1.4 (0.5)	1.5 (0.6)	<0.001 ^b
Physical activity, (1-7)	3500	5.2 (1.4)	5.1 (1.5)	5.1 (1.5)	4.9 (1.5)	<0.005 ^b

^aBecause of rounding, percentages may not total 100%.

^bANOVA, analysis of variance

^cPearson X² test

TABLE 3 Linear Regression Analyses for BMI in Relation to Exposure to Interpersonal Violence, Age and Development, Socioeconomic, Psychosocial and Lifestyle Factors, according to Gender.^{abcde}

	Regression coefficients (95% CIs)			
	BMI			
	Girls		Boys	
	Separate regressions	Fully adjusted model	Separate regressions	Fully adjusted model
<i>Exposure to Interpersonal violence</i>				
1 type	0.53 (0.21, 0.85)	0.33 (0.01, 0.65)	0.51 (0.19, 0.82)	0.40 (0.09, 0.71)
2 types	1.25 (0.73, 1.76)	0.89 (0.37, 1.41)	0.59 (0.15, 1.03)	0.35 (-0.09, 0.79)
≥3types	0.95 (0.34, 1.57)	0.47 (-0.17, 1.10)	-0.13 (-0.77, 0.51)	-0.54 (-1.20, 0.11)
Overall p-value	<0.001	0.003	0.002	0.008
<i>Age and Development</i>				
Age	0.39 (0.31, 0.46)	0.34(0.25, 0.42)	0.45 (0.36, 0.55)	0.41 (0.31, 0.51)
Pubertal status	0.96 (0.71, 1.21)	0.83 (0.59, 1.08)	0.72 (0.49, 0.96)	0.65 (0.41, 0.89)
Early pubertal timing	1.02 (0.68, 1.35)	0.79 (0.46, 1.12)	0.63 (0.31, 0.96)	0.54 (0.22, 0.86)
<i>Socioeconomic factors</i>				
Living without both parents ^d	0.30 (0.06, 0.54)	0.01(-0.23, 0.26)	0.47 (0.21, 0.72)	0.33 (0.07, 0.59)
Family economy below average ^e	0.63 (0.23, 1.03)	0.17 (-0.25, 0.58)	0.53 (0.06, 1.00)	0.12 (-0.36, 0.61)
<i>Psychosocial Factors</i>				

Loneliness ^c				
Seldom lonely	-0.01 (-0.31, 0.29)	-0.17 (-0.47, 0.14)	0.01 (-0.28, 0.30)	-0.14 (-0.43, 0.15)
Sometimes lonely	0.53 (0.22, 0.85)	0.15 (-0.21, 0.52)	0.24 (-0.11, 0.59)	-0.06 (-0.43, 0.30)
Often lonely	1.05 (0.54, 1.55)	0.65 (0.07, 1.22)	0.96 (0.30, 1.62)	0.37 (-0.34, 1.09)
Very often lonely	1.67 (1.09, 2.24)	0.99 (0.29, 1.69)	0.71 (-0.06, 1.49)	0.27 (-0.56, 1.10)
Overall p-value	<0.001	0.002	0.015	0.529
Self-esteem	-0.75 (-0.94, -0.56)	-0.45 (-0.70, -0.20)	-0.68 (-0.90, -0.46)	-0.53 (-0.80, -0.26)
Psychological distress	0.44 (0.24, 0.63)	-0.50 (-0.76, -0.23)	0.22 (-0.05, 0.50)	-0.54 (-0.89, -0.20)
Family cohesion	-0.25 (-0.39, -0.12)	0.14 (-0.02, 0.30)	-0.16 (-0.32, 0.01)	0.23 (0.04, 0.41)
<i>Lifestyle Factors</i>				
Meal frequency	-0.67 (-0.85, -0.49)	-0.41 (-0.61, -0.21)	-0.70 (-0.93, -0.47)	-0.44 (-0.68, -0.19)
Eating problems	0.77 (0.5, 0.97)	0.59 (0.38, 0.81)	1.10 (0.82, 1.38)	1.08 (0.79, 1.38)
Physical activity	-0.13 (-0.22, -0.04)	-0.02 (-0.11, 0.07)	-0.28 (-0.37, -0.20)	-0.22 (-0.31, -0.14)

BMI, Body Mass Index.

^aStudy definitions and measures are defined in Tables 1-2.

^bReference category for categorical variables: Interpersonal violence, no exposure; Early Pubertal Timing, menarche ≥ 12 years of age in girls and self-rated average or late pubertal timing in boys; Loneliness, never or very seldom lonely; Family Structure, living with both parents; Family Economy, average.

^cLinear Regression Analysis with Multiple Imputation.

^dAll linear regression analyses are adjusted for age and pubertal status.

^eUnderweight adolescents were excluded from analysis.